



## The reappearance of *Puma concolor* (Linnaeus, 1771) (Mammalia, Carnivora, Felidae) in the city of Rio de Janeiro, Brazil

Jorge Antônio Lourenço Pontes<sup>1\*</sup>, Rafael Andrada de Araújo Martins<sup>2</sup>, Luiz Eduardo Mendonça Regio<sup>1</sup>, Mário Luiz Gomes Soares<sup>3</sup>, Filipe de Oliveira Chaves<sup>3</sup>, Helena Godoy Bergallo<sup>4</sup>

**1** Programa de Pós-Graduação em Ensino de Ciências, Ambiente e Sociedade Universidade do Estado do Rio de Janeiro, São Gonçalo, RJ, Brazil

• JP pontesjal@hotmail.com  <https://orcid.org/0000-0003-2741-4273> • LR luizregio@hotmail.com  <https://orcid.org/0000-0002-6588-1123>

**2** Laboratório de Zoologia de Vertebrados, Centro Universitário São José, Rio de Janeiro, RJ, Brazil • RA andrada88rafael@gmail.com  <https://orcid.org/0000-0001-7663-8949>

**3** Núcleo de Estudos em Manguezais, Faculdade de Oceanografia, Universidade do Estado do Rio de Janeiro, Rio de Janeiro, RJ, Brazil • MS mariolgs@gmail.com  <https://orcid.org/0000-0002-3312-7257> • FC fochaves@gmail.com  <https://orcid.org/000-0001-7114-7585>

**4** Departamento de Ecologia, Universidade do Estado do Rio de Janeiro, Rio de Janeiro, RJ, Brazil • HB nena.bergallo@gmail.com  <https://orcid.org/0000-0001-9771-965X>

\* Corresponding author

### Abstract

Large mammals, especially felids such as Mountain Lion, *Puma concolor* (Linnaeus, 1771), are disappearing from their original habitats, due to the loss of natural areas and hunting, especially in the metropolitan regions. In the city of Rio de Janeiro, Brazil, *P. concolor* had not been observed for almost a century, despite the city having forest fragments as large as 10,000 ha. Here we present records that confirm the reappearance of this species in the city of Rio de Janeiro, where it has been considered extirpated.

### Keywords

Atlantic Forest, extirpation, metropolitan region, protected areas, wild cats

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### Introduction

Mammal populations, especially of large predators, are declining in the city of Rio de Janeiro, with some species such as the Jaguar, *Panthera onca* (Linnaeus, 1758), already extirpated (Vaz 1985; Bergallo et al. 2000; Vera Y Conde et al. 2000). The Mountain Lion, *Puma concolor* (Linnaeus, 1771), has a geographic distribution that encompasses both North and South America, from Canada to the Patagonian Argentina (Oliveira and Cassaro 2005; Reis et al. 2011; Nielsen et al. 2015). Six

subspecies of *P. concolor* are recognized (Culver et al. 2000), this species not considered globally threatened and is classified as Least Concern in the IUCN Red List of Threatened Species (Nielsen et al. 2015), but the population from eastern United States, was extirpated in 2018 (Racey and Kloer 2018). Despite the broad distribution in all Brazilian biomes, populations of *P. concolor* subspecies are in decline in several regions, such as in the Caatinga (*P. concolor greeni* (Nelson & Goldman, 1931))

and in the south-southeastern Atlantic Forest (*P. concolor concolor* (Linnaeus, 1758)) (Reis et al. 2011; Matte 2012; Nascimento and Garbino 2013; Cronemberger et al. 2018). *Puma concolor* is classified as Vulnerable in Brazil (Brasil 2014) and the state Rio de Janeiro (Estado do Rio de Janeiro 1998; Bergallo et al. 2000), mainly due to habitat loss and poaching (Rocha et al. 2003; Bergallo et al. 2009).

There were no records proving the occurrence of *P. concolor* for more than 80 years from the city of Rio de Janeiro (Côrrea 2017), despite having been considered a rare species in the 1980s, without evidence (Vaz 1985). To the best of our knowledge, it has not been documented in Rio de Janeiro in the last 80 years (Corrêa 2017), and it was officially declared Extinct in the Municipal List of Threatened Species of Flora and Fauna (Vera Y Conde et al. 2000).

Despite anecdotal comments on the reappearance of *P. concolor* in Rio de Janeiro, in the two largest forest fragments on the Gericinó-Mendanha and Pedra Branca mountain ranges, no unambiguous records (e.g., photographs, footprints) have been available until now. Here, we confirm the current presence of *P. concolor* in the city of Rio de Janeiro.

## Study Area

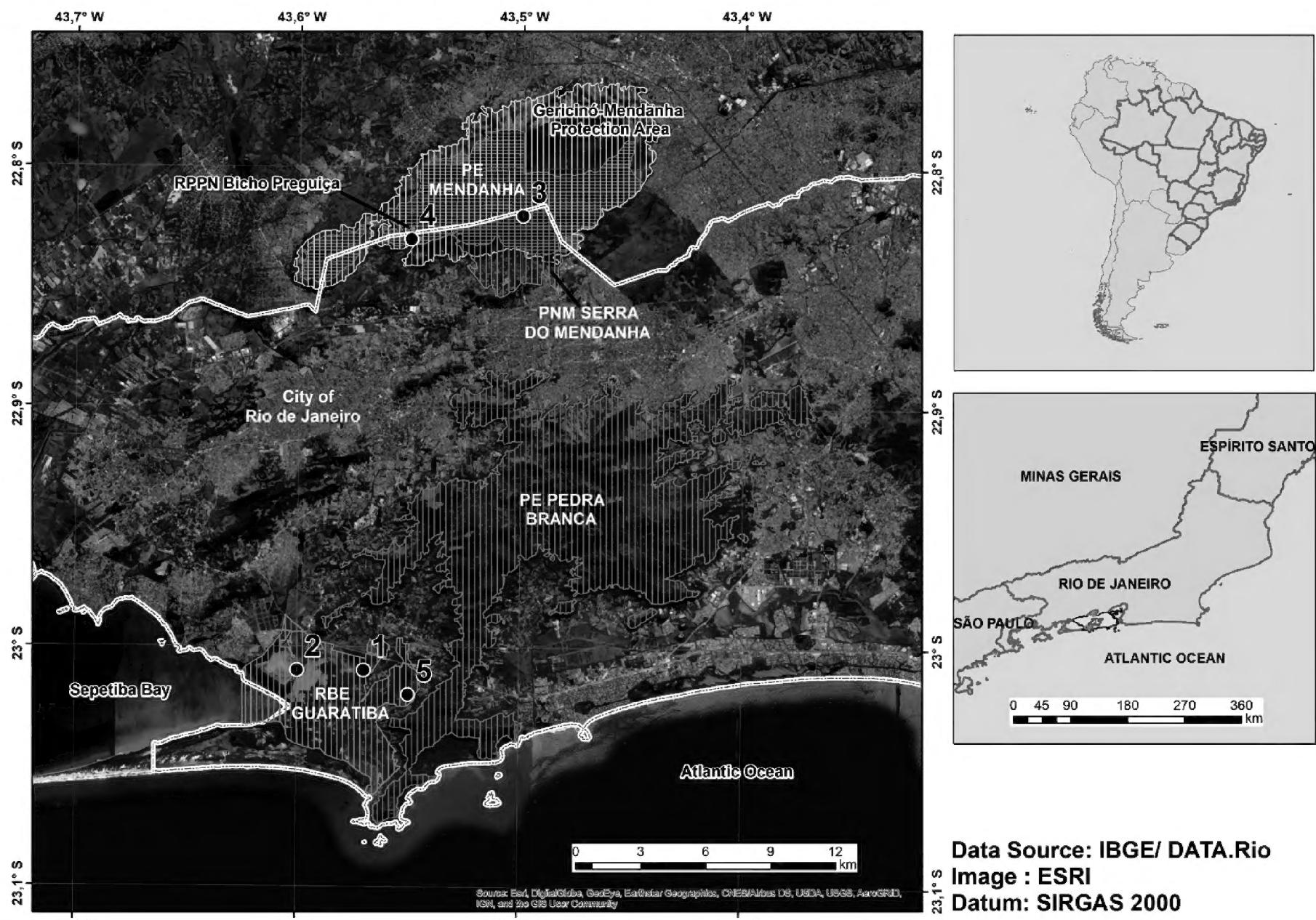
Pedra Branca State Park (PE Pedra Branca) covers an

area of 12,492 ha and is inserted in the Pedra Branca Mountain Range in the city of Rio de Janeiro (Rio de Janeiro hereafter) (Coura et al. 2009; INEA 2013; Castro 2015) (Fig. 1).

The Reserva Particular do Patrimônio Natural Bicho Preguiça (RPPN Bicho Preguiça hereafter) has an area of 1.73 ha and is located in located in the Gericinó-Mendanha mountain range. Mendanha State Park (PE Mendanha) and Serra do Mendanha Natural Municipal Park (PNM Serra do Mendanha) are also located in the same mountain range (INEA 2014; Castro 2015; Martins and Pontes 2019) (Fig. 1).

The Guaratiba State Biological Reserve (RBEG) is approximately 50 km from downtown Rio de Janeiro, located on the Sepetiba/Guaratiba coastal plain in the Piracão and Portinho watersheds. It covers approximately 3,360 ha along the eastern side of Sepetiba Bay, between the Piraquê River and Guaratiba Hill (Fig. 1). The reserve encompasses a complex of islands, rivers, and canals with extensive mangrove forests (2,090 ha) and salt flats (740 ha) (Estrada et al. 2013; Castro 2015; Soares et al. 2017).

RBEG is inserted in a highly connected landscape characterized by several subdivisions: (i) Pedra Branca mountain range; (ii) Coastal plain (rivers, freshwater wetlands, coastal scrub (restinga hereafter), salt-flats and mangrove forests); (iii) Sepetiba Bay (estuary, tidal



**Figure 1.** Map *Puma concolor* records in the city of Rio de Janeiro: 1 and 2 = RBE Guaratiba (2007 and 2008); 3 = PE Mendanha and PNM Serra do Mendanha (2008); 4 = RPPN Bicho Preguiça (2018 and 2020); 5 = Roberto Burle Marx Property, Barra de Guaratiba, contiguous to PE Pedra Branca (2020). Insert maps show the location of Rio de Janeiro state in southeastern Brazil.

channels, mangrove forests on islands and mud banks); (iv) Restinga da Marambaia (mangrove forests, restinga, dunes, freshwater wetlands, and beaches); and (v) Ocean.

The connection between the types of ecosystems in this region can also be observed, not only by differences in vegetation, but also by the flow of freshwater from the slopes of the Pedra Branca mountain range to the coastal plain, which feeds the shallow (1.5 m) Guaratiba aquifer (Vicent et al. 2010).

## Methods

An inventory of terrestrial mammals has been ongoing since June 2015 in the RPPN Bicho Preguiça. Six camera traps were set up without the use of baits, combined with 1,540 h of active search on trails where *Puma concolor* footprints were observed (Martins and Pontes 2019). Field equipment included a laptop to download data, cell phones with a georeferencing app, camera traps, gypsum to make footprint molds, and a ruler in millimeters.

Geographic coordinates use the SIRGAS 2000 datum.

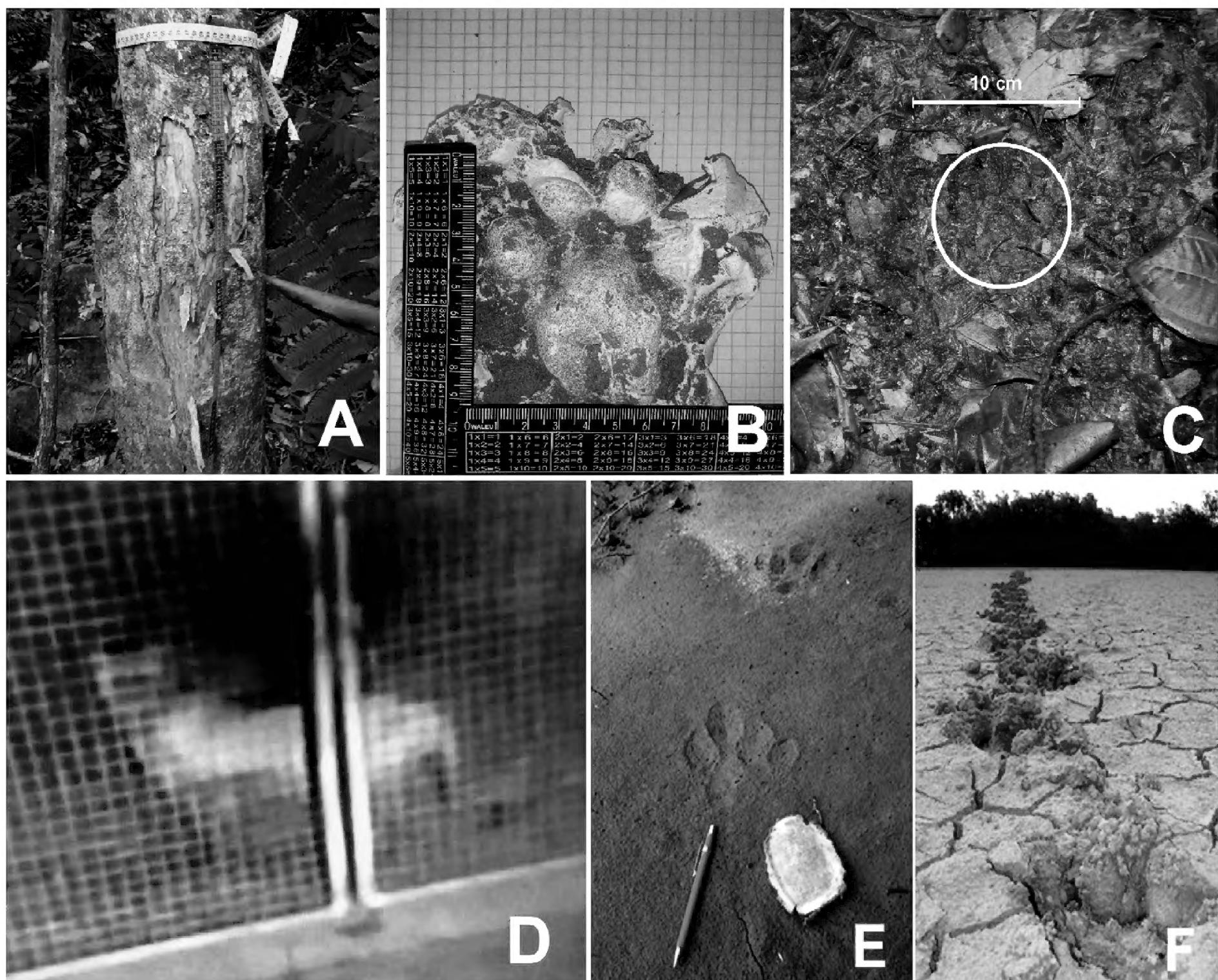
Additionally, records derived from other Universidade do Estado do Rio de Janeiro field activities were incorporated in our study: the herpetofauna of Serra do Mendenha by the Laboratório de Ecologia de Vertebrados, and mangrove forests and salt flats in the RBEG by the Núcleo de Estudos em Manguezais.

## Results

### *Puma concolor* (Linnaeus, 1771)

Figures 1, 2

**New records.** BRAZIL – Rio de Janeiro • city of Rio de Janeiro; near the Piracão River RBE Guaratiba; 23.01°S, 043.57°W; 2 m alt.; Bergallo and Pontes leg.; 2007; footprint • city of Rio de Janeiro; RBE Guaratiba; salt flats associated with mangrove forests; 23.01°S, 043.60°W; 2 m alt.; Soares and collaborators leg.; 2008; footprint and



**Figure 2.** Evidence of *Puma concolor* in the city of Rio de Janeiro. **A.** Scratch marks on a tree trunk in RPPN Bicho Preguiça, Gericinó-Mendanha massif (2020). **B.** Footprint mold of anterior paw in RPPN Bicho Preguiça, Gericinó-Mendanha mountain range (2019). **C.** Anterior paw footprint recorded at 700 m altitude in PNM Serra do Mendanha, Gericinó-Mendanha mountain range (2008). **D.** Individual at the gate of the Roberto Burle Marx Property, Barra de Guaratiba, Pedra Branca mountain range (June 2020). **E, F.** Footprints RBE Guaratiba, Barra de Guaratiba (2007 and 2008). Photographs by Rafael Andrade (A, B); Jorge Pontes (C); security camera in the Roberto Burle Marx Property (D); Núcleo de Estudos em Manguezais (E, F).

scratch marks on tree trunks • city of Rio de Janeiro; PNM Serra do Mendenha; 22.82°S, 043.50°W; 700 m alt.; Pontes and collaborators; 05.VII.2008; footprint • city of Rio de Janeiro; RPPN Bicho Preguiça; 22.77°S, 043.60°W; 245 m alt.; Martins and Pontes leg.; 16.VIII.2019; footprint and mold • city of Rio de Janeiro; RPPN Bicho Preguiça; 22.83°S, 043.55°W; 321 m alt.; Martins and Pontes leg.; 15.VIII.2020; scratch marks on tree trunks • city of Rio de Janeiro; Roberto Burle Marx Property, Pedra Branca mountain range; 23.02°S, 043.55°W; 15 m alt.; Pontes leg.; 30.VI.2020; security camera.

**Identification.** *Puma concolor* is a large cat of the subfamily Felinae and the second-largest New World cat after Jaguar, *Panthera onca* (Linnaeus, 1748), from which it can be differentiated by the lack of spots and a uniform color dorsal pelage. *Puma concolor* can reach 230 cm in length from snout to tail and more than 70 kg in body mass. Its pelage varies in color from lighter grayish brown to darker reddish brown, and the tip of the tail is black. Another species of cat, *Herpailurus yagouaroundi* (É. Geoffroy Saint-Hilaire, 1803), can occur in anthropic environments (Culver et al. 2000; Leite 2000; Matte 2012; Caso et al. 2015; Ferreira et al. 2018; ICMBio 2018; Martins and Pontes 2019), but *H. yagouaroundi* can be differentiated from *P. concolor* by its smaller size (approximately 8 kg and 80 cm total length), more elongated body, short legs, and dark brown color, as well as not being from a genetically close group (Culver et al. 2000; Caso et al. 2015; Reis et al. 2011). Secretive and largely solitary, *P. concolor* is both nocturnal and crepuscular, although daytime sightings do occur. This species is an ambush predator which pursues a wide variety of prey. Individuals are territorial and live at low population densities (Silva 1994; Oliveira and Cassaro 2005; Reis et al. 2011; Matte 2012; ICMBio 2018).

## Discussion

Our new data confirm that *Puma concolor* is not extirpated in coastal Rio de Janeiro state and that it is recolonizing the city of Rio de Janeiro. It is now present at least in the Gericinó-Mendenha and Pedra Branca mountain ranges and in the RBEG (Figs. 1, 2).

Individuals of *P. concolor* in the city of Rio de Janeiro may have dispersed from the Serra do Tinguá and surrounding areas (Cronemberger et al. 2018), first colonizing the Gericinó-Mendenha mountain range, then the Pedra Branca mountain range and lowlands, as in the RBEG. The presence of Collared Pecary, *Dicotyles tajacu* (Linnaeus, 1758), in the Gericinó-Mendenha mountain range (Martins and Pontes 2020), may attract and provide prey for *P. concolor*. Wild pigs are typically prey of *P. concolor* (Sana and Cullen Jr 2008; Reis et al. 2011).

Although *P. concolor* is not usually hunted in Rio de Janeiro state (Ferreira et al. 2018), there was a recent social media post of a mountain lion killed by a hunter

in Serra dos Órgãos (O Globo 2019). Events like this threatened the existence of animals occurring in the fragmented Atlantic Forest (Cullen Jr. et al. 2001; Souza and Alves 2014; Galetti et al. 2016; Cronemberger et al. 2018), especially in densely populated areas such as the Rio de Janeiro metropolitan region, where hunting is still a common, albeit illegal, practice (Vaz 1985; Ferreira et al. 2018).

The record of *P. concolor* made by a security camera in the Roberto Burle Marx Property, which is in the foothills of the Pedra Branca mountain range, and records of footprints on the salt flats in RBEG strongly suggest expanded home range that includes resources available on the Guaratiba coastal plain.

Although the occurrence of wild cats in mangroves is known worldwide (Saenger et al. 1983; Fernandes 2000), there are few records of *P. concolor* in mangroves in Brazil. Mazzolli (1993) reported the occurrence of this species in restinga and mangroves on the coastal plain of Santa Catarina, and according to this author, only one of 22 mountain lion records in the state was obtained on the coastal plain of that state, probably due to the higher human population along the coast. As in northern Santa Catarina, coastal areas of Paraná and southern São Paulo states are more sparsely populated (Mazzolli 1993). In fact, Leite (2000) reported the presence of *P. concolor* in Superagui National Park and in the Guaraqueçaba Environmental Protection Area, both in coastal Paraná state. Martins et al. (2008) also reported the occurrence of *P. concolor* on the coast of São Paulo state, in the Juréia-Itatins Ecological Station, although they did not specifically mention that animals were living in mangroves.

In addition to written reports on the presence of wild cats in mangroves, oral communications about observations of animals and footprints in mangroves have been made by members of traditional communities, fishermen, and managers of protected areas; some sightings of animals have been video edition or photographed (Fundação Florestal 2019; G1 2020). Researchers at the Núcleo de Estudos em Manguezais (Universidade do Estado do Rio de Janeiro) have also reported the presence of wild cats in mangroves in Cananéia, Bertioga (both in São Paulo state), Guaratiba (Rio de Janeiro state), and Sucuriú (Amapá state). All these records are from areas where mangroves occur at the border of relatively well-conserved terrestrial ecosystems in landscapes where terrestrial and coastal-estuarine systems are widely connected.

Hutchings and Saenger (1987) highlighted that most terrestrial vertebrates use mangroves as an extension of their native ranges, as alternative refuges, connection between two terrestrial ecosystems, protection against predators, and feeding grounds. Considering that the Guaratiba mangroves are on the border of the coastal landscape and therefore not connecting different terrestrial ecosystems, wild cats in Brazil are occasional mangrove users, and wild cats are at the top of the food chain, one of our hypotheses is use the Guaratiba mangroves to forage for animal prey and refuge.

The occurrence of *P. concolor* in the city of Rio de Janeiro municipality highlights both the importance of conserving forest remnants and the need to maintain and increase connectivity between these remnants. Our records from the Guaratiba lowlands (Baixada de Guaratiba) also suggest the importance of landscape connections between different ecosystem types in the Atlantic Forest domain (Marone et al. 2009).

The conservation of *P. concolor* and other threatened mammal species in the city of Rio de Janeiro depends on state and municipal public policies targeting these species, including proper management and vigilance, especially in the PE Mendarha (4,398 ha) and PE Pedra Branca (12,492 ha) (Castro 2015). However, the protection of smaller reserve areas, both municipally and privately owned (such as RPPN Bicho Preguiça), as well as unprotected natural areas, such as Camboatá Forest, is still important. Such smaller areas can function as steppingstones for the transit of *P. concolor* and other species (Oliveira et al. 2015; Pontes et al. 2015; Pontes et al. 2020).

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## Authors' Contributions

Conceptualization: JALP. Data curation: FOC. Formal analysis: JALP, HGB. Investigation: JALP, RAAM, LEMR, MLGS, FOC, HGB. Methodology: RAAM, MLGS, FOC. Resources: RAAM. Supervision: JALP. Visualization: RAAM, LEMR, FOC. Writing – original draft: JALP, MLGS, HGB. Writing – review and editing: JALP, HGB.

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